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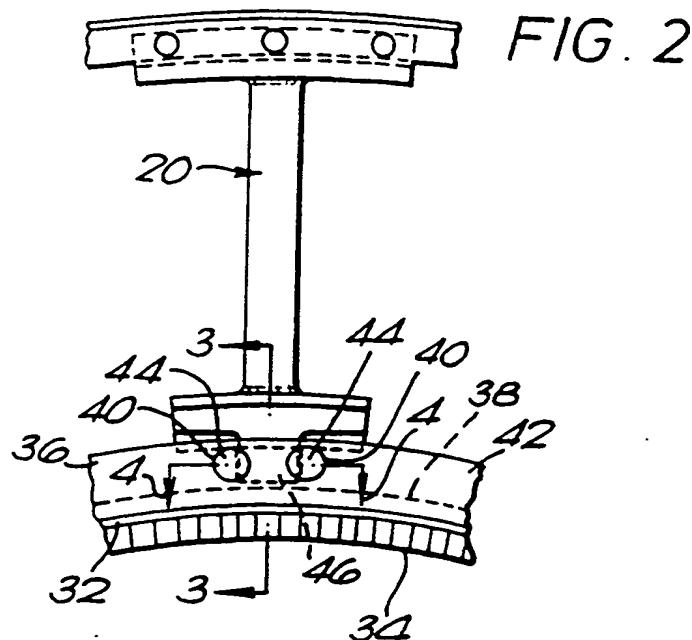
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54 Labyrinth seal support.

57 The normally multi-part gas turbine engine labyrinth seal outer portion which carries an abradable lining (34), is formed from a single piece and has a groove (38) machined in its periphery for the receipt of the feet (46) of respective stator vanes (20). Pins

(44) are fitted in pairs through the walls (42) of the groove to provide lateral location for the feet. The pins (44) and a groove liner (52) are made from an anti-fretage material.



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IMPROVEMENTS IN OR RELATING TO LABYRINTH SEAL STRUCTURES

The present invention relates to support means for labyrinth seals. The invention has particular efficacy when utilised in gas turbine engines.

A labyrinth seal of the kind mentioned herein is defined by an outer annular land which has a number of annular fins formed on its outer diameter, the fins being surrounded in close spaced relationship by a further annular land, the bore of which has an abradable lining.

The finned portion is coaxially fixed to a rotor for rotation therewith within the lined portion which in turn, is non rotatably supported by the inner ends of a fixed stage of stators or guide vanes.

It is necessary to enable relative, opposing radial growth between the stators or guide vanes and the associated further annular land which results from increases in operating temperatures in the associated engine.

It is the practice to provide the further land with an annular flange and to locate inwardly directed features on the inner ends of the stators or guide vanes between that flange and a further, separate flange, the two flanges being bolted together by a number of angularly spaced nuts and bolts.

Radial slots have to be machined in the opposing face of at least one of the flanges and the features placed therein, to be restrained against excessive movement peripherally of the flanges, by the side walls of the slots. The arrangement is expensive to produce and heavy.

The present invention seeks to provide an improved outer labyrinth seal land of the kind defined hereinbefore.

It is a further object of the present invention to provide an anti frettage liner which in operation protects the inwardly directed feature on the stator or guide vane against frettage.

According to one aspect of the present invention a labyrinth seal comprises an annular land having an internal abradable lining and an outwardly turned annular flange which has an annular groove formed in its periphery, a number of angularly spaced pairs of pins spanning the annular groove, all of said pins being fixed by their ends in the walls of the groove and wherein the pins in each pair of pins are spaced one from the other by a distance which enables the insertion therebetween of an inwardly directed feature on the inner ends of a plurality of stators or guide vanes which are to be associated therewith.

According to a further aspect of the present invention there is provided an anti frettage lining comprising a segmented annular member, wherein a substantial portion of each segment is formed so as to compliment the profile of a groove in the

periphery of the outwardly turned flange of the outer portion of a labyrinth seal in which for operation the anti frettage liner is to be fitted and the resulting lips of the liner are turned back upon themselves to provide edges the distance between which is less than the thickness of the outwardly turned flange, the material from which the liner is formed being considerably harder than that of the outwardly turned flange.

The invention will now be described, by way of example and with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic view of a gas turbine engine incorporating an embodiment of the present invention.

Figure 2 is an enlarged view on line 2-2 of Figure 1.

Figure 3 is a view on line 3-3 of Figure 2.

Figure 4 is a view on line 4-4 of Figure 2.

Figure 5 depicts the retaining pins of Figures 2 to 4 inclusive.

Figure 6 illustrates the incorporation of a further embodiment of the present invention.

Figure 7 is a pictorial view of the further embodiment incorporated in Figure 6.

Referring to Figure 1. A gas turbine engine 10 includes a compressor 12, combustion equipment 14, a turbine section 16 and an exhaust section 18, all arranged in flow series.

In this example, the turbine section has a stage of guide vanes 20 affixed in known manner via their radially outer ends, to structure within the engine turbine casing 22. A stage of rotatable turbine blades 24 is positioned immediately downstream of the stage of guide vanes 22, again in known manner.

The turbine disc 26 has an annular land 28 bolted to its upstream face, which land extends forwardly and terminates under the guide vanes 20. That portion of the land 28 which lies under the guide vanes 20 has annular fins 30 formed on its outer diameter in known manner and these are surrounded in close spaced relationship by a further annular land 32 which has an abradable lining (not shown in Figure 1) in its bore, again in known manner.

Referring now to Figure 2. In accordance with the present invention the land 32 with its associated abradable lining 34 has an outwardly turned annular flange 36 formed at its downstream end. The flange 36 has an annular groove 38 formed in its periphery. A plurality of equi-angularly spaced pairs of holes 40, only one of which pairs is shown, are drilled through the resulting walls 42 of the groove 38 and a pin 44 is fitted in each hole 42. It

is intended that the pins 44 should stay in situ until their replacement through wear is necessitated. They may thus be a press fit or may be brazed via their ends to the groove walls 42, or both.

Each pin 44 in a pair of pins is spaced one from the other by a distance which will allow the insertion of a foot 46 therebetween one of which feet 46 projects from the underside of each respective guide vane 20. It follows that the number of pairs of pins 44 equals the number of guide vanes 20 in the stage.

Each guide vane 20 is affixed via its outer end to fixed engine structure in known manner. Consequently, during operation of the engine 10, when the guide vanes 20 become heated, they expand radially inwardly towards the engine axis. Conversely the land 32 and its associated grooved flange 36 expand radially outwardly from the engine axis. Thus there must be an appropriate clearance between the feet 46 and the associated pins 44. This is shown in Figures 2 and 4. There must also be a clearance between the feet 46 and the walls 42 of the groove 38. This is shown in Figure 3.

Referring now to Figure 5. The pins 44 in the present example are relieved at 48 and 50 respectively, so as to provide flat opposing faces. A greater surface area is thus provided for the feet 46 (not shown in Figure 5) to bear on. This, depending on the friction characteristics of the assembly, which would be ascertained on test of the associated engine, may prove to be an unnecessary step. In any event, the contacting surfaces of the feet 46 and the inner surface of walls 42 will be pre-coated with an anti frettage material e.g. a material sold under the proprietary name "HAYNES 25". The coating may be applied by hot spraying of the material onto the appropriate surfaces. Alternatively, a preform 52 as depicted in Figure 6 may be used to cover the profile of the groove 38.

The preform 52 which is depicted per se in Figure 7 could be produced by hot spraying as with a plasma gun, a metal powder onto a disposable core (not shown) and would have its lips 54 turned inwardly upon themselves so as to provide upwardly turned edges 56 within the maximum width of the preform 52 and which on fitting of the preform within the groove 38, will clip into further grooves 58 and 60 in the outer surfaces of the walls 42.

The pins 44 will be manufactured from the anti frettage material.

The obviation of a groove formed by an assembly of separate flanges, along with associated fastening and locking devices, and of the need for extensive machining operation which such arrangements made necessary, results in a considerable cost and weight reduction and a simplified assem-

bly procedure.

Claims

5. 1. A labyrinth seal for a gas turbine engine, comprising an annular land having an internal abradable lining and characterised by a radially outwardly turned flange (36) which has an annular groove (38) formed in its periphery, a number of angularly spaced pairs of pins (44) spanning the annular groove (38), all of said pins (44) being fixed by their ends in the walls (42) of the groove (38) and wherein the pins (44) in each pair of pins are spaced, one from the other, by a distance which enables the insertion therebetween of an inwardly directed feature on the inner ends (46) of a plurality of stator vanes (20) which are to be associated therewith.
10. 2. A labyrinth seal as claimed in claim 1 and characterised by each pin (44) having a flat (48 or 50) formed on its mid length and each pin (44) in each pair of pins being orientated such that the flats (48,50) face each other, so as to provide opposing planer bearing surfaces for respective stator vane features (46).
15. 3. A labyrinth seal as claimed in claim 1 or claim 2 characterised in that each pin (44) is made from an anti-frettage material.
20. 4. A labyrinth seal as claimed in any previous claim characterised by the inclusion of a liner comprising "U" section segments (52) made from an anti-frettage material, proportioned so as to fit closely against the walls within the annular groove (38) and having holes therein for the passage of said pins (44) and means (54,56) for retaining the segments in situ.
25. 5. A labyrinth seal as claimed in claim 4 characterised in that the means (54), comprises, the free edges of the liner (52) which are outwardly turned and then downwardly and upwardly turned so as to enable clipping of the liners (52) in retaining manner in the annular groove (38), the upturned free edge portions (56) of the liner (52) being located in respective annular grooves (58,60) provided in the respective upstream and downstream faces of the annular flange (36).
30. 6. A liner for lining an annular peripheral groove in a radially outwardly turned flange on a labyrinth seal structure for a gas turbine engine, characterised by a generally "U" section segment (52) made from an anti-frettage material and proportioned so as to fit closely against the walls within the groove (38) and means (54) for retaining the segment (52) therein.
35. 7. A liner as claimed in claim 7 characterised in that the means (54) comprises the free edges of the liner segment (52) which are turned outwardly,

downwardly and upwardly so as to enable clipping of the upwardly turned edge portions (56) into annular grooves (58,60) in the respective upstream and downstream faces of the radially outwardly turned flange on a labyrinth seal structure to be associated therewith.

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8. A combination characterised by a liner (52) of generally "U" section shape and forming a segment of an annulus and made from an anti-frettagge material, and proportioned so as to closely fit against the walls of an annular groove (38) in the radially outwardly turned flange (42) of a labyrinth seal structure for a gas turbine engine, and a plurality of pins (44) made from an anti-frettagge material, said pins (44) being proportioned so as to fixedly engage in holes (40) through the walls (42) of said groove (38) at positions which enable the insertion therebetween of features on stator vanes (20) of a said gas turbine engine.

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9. A combination as claimed in claim 8 characterised by each of the pins (44) being provided with a flat (48 or 50) at its mid length and in use is positionally arranged with another of said pins (48 or 50) in said flange (36) so that flats (48,50) face each other.

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10. A gas turbine engine characterised by the inclusion of a labyrinth seal as claimed in any of claims 1 to 5 of this specification.

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FIG. 1

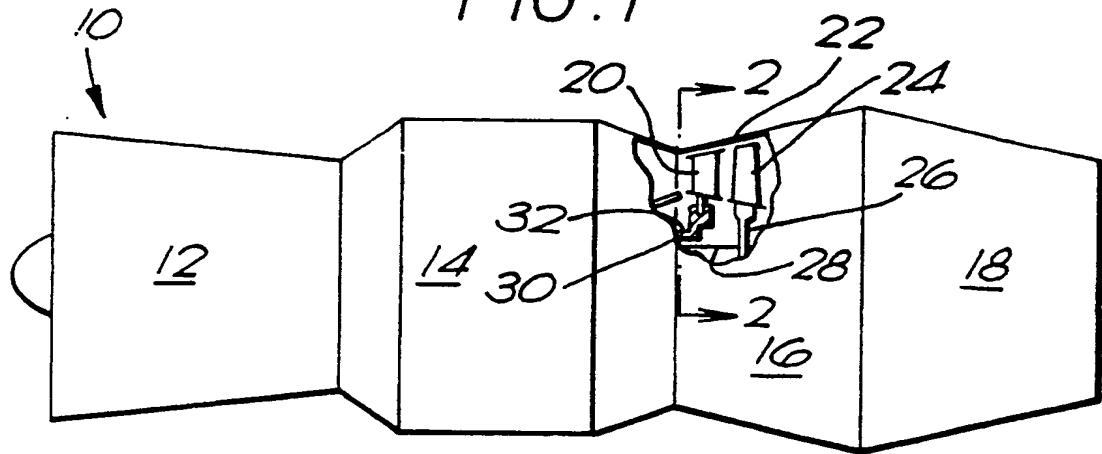


FIG. 2

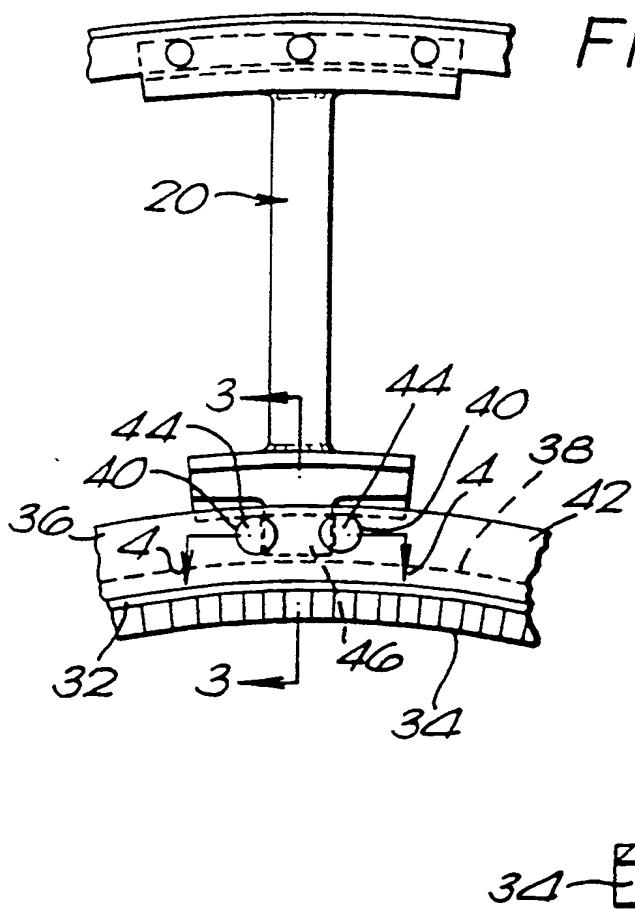


FIG. 3

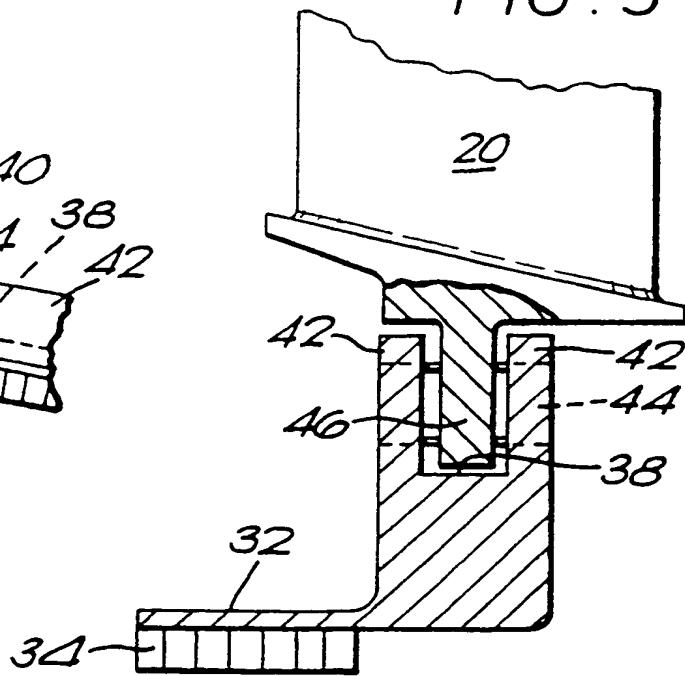


FIG. 4

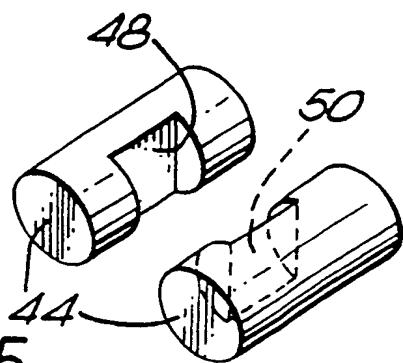
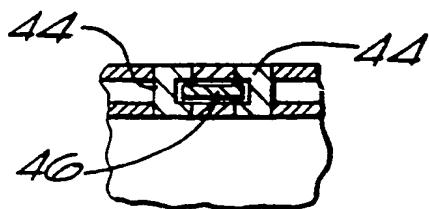


FIG. 5

FIG. 7

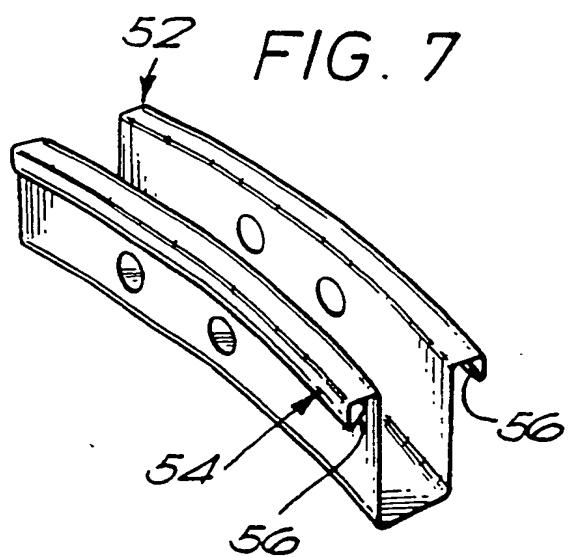
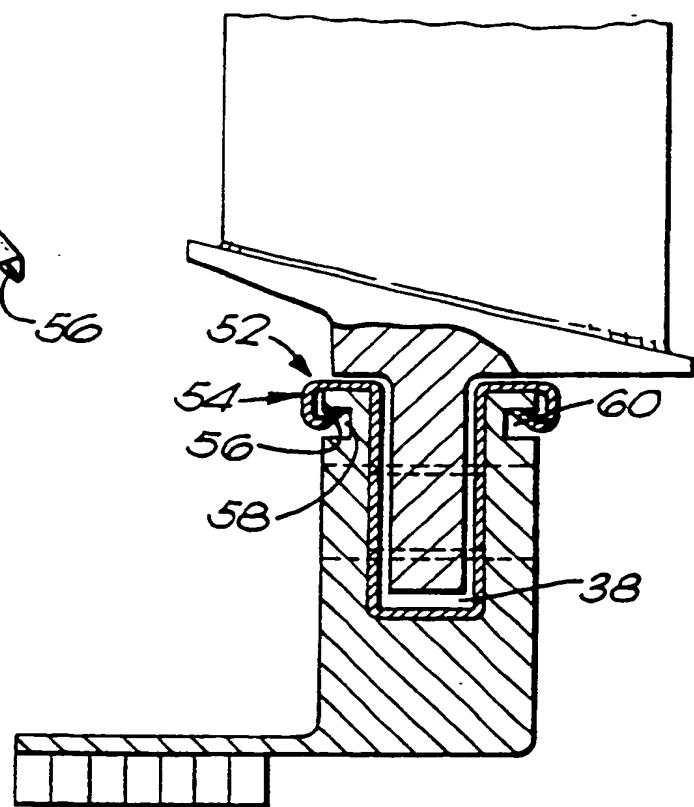


FIG. 6





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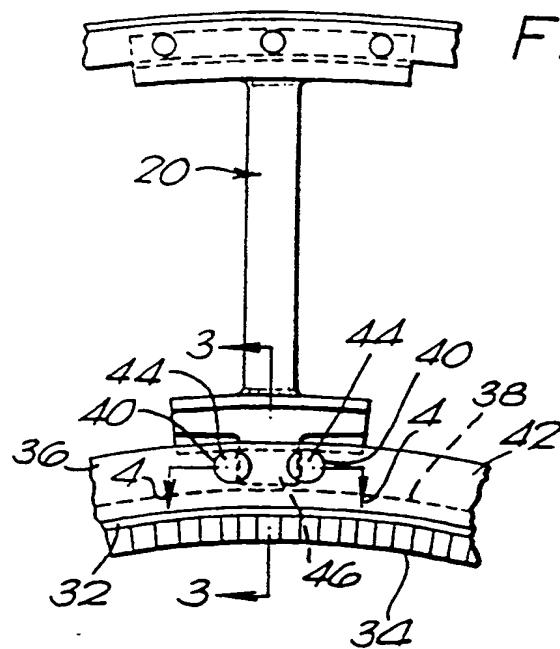
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㉔ Labyrinth seal support.

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FIG. 2





DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.5)						
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim							
Y	US-A-3 411 794 (R.I. ALLEN) * Column 1, lines 33-43; column 1, line 62 - column 2, line 26; figure 1 *	1-3	F 01 D 11/00 F 01 D 11/02						
Y	---	4-5							
Y	GB-A-2 110 768 (ROLLS-ROYCE LTD) * Page 1, lines 30-75; figure 1; page 2, lines 113-115 *	1-3							
Y	---								
Y	CH-A- 250 728 (GEBRUDER SULZER AG) * Page 1, line 62 - page 2, line 19; figure 6 *	1-3							
Y	---								
A	CH-A- 317 252 (MASCHINENFABRIK AUGSBURG-NÜRNBERG AG) * Page 3, lines 50-55; figure 4 *	4-5							
A	---								
A	US-A-4 701 102 (F.A. PISZ) * Column 1, line 59 - column 2, line 30; figures *	1-2							
A	---								
A	US-A-4 215 181 (R.K. BETTS) * Abstract *	3	TECHNICAL FIELDS SEARCHED (Int. Cl.5)						
	-----		F 01 D						
<p>The present search report has been drawn up for all claims</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">Place of search</td> <td style="width: 33%;">Date of completion of the search</td> <td style="width: 34%;">Examiner</td> </tr> <tr> <td>THE HAGUE</td> <td>28-11-1990</td> <td>DIMITROULAS P.</td> </tr> </table>				Place of search	Date of completion of the search	Examiner	THE HAGUE	28-11-1990	DIMITROULAS P.
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THE HAGUE	28-11-1990	DIMITROULAS P.							
CATEGORY OF CITED DOCUMENTS		<p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons</p> <p>& : member of the same patent family, corresponding document</p>							
<p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p>									



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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- All claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for all claims.
- Only part of the claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claims:
- No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

X LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions.

namely:

See sheet -B-

- All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid.
- namely claims:
- None of the further search fees has been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims.

1-5, 10

namely claims:



LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions.

namely:

1. Claims 1-5,10: A support structure for a labyrinth seal, involving pins and a liner.
2. Claims 6-7: A liner.
3. Claims 8-9: A combinationto enable the insertion of features on stator vanes.